

DESCRIPTIONS OF THE TADPOLES OF SOME AUSTRALIAN LIMNODYNASTINE LEPTODACTYLID FROGS

by MARGARET DAVIES*

Summary

DAVIES, M. (1991) Descriptions of the tadpoles of some Australian limnodynastine leptodactylid frogs. *Trans. R. Soc. S. Aust.* 115(2), 67-76, 31 May, 1991.

Early development and late stage larvae of the limnodynastine frog species *Heleioporus albopunctatus* and larvae of *Neobatrachus centralis*, *N. wilsmorei*, *N. kunapalari* and *Mixophyes schevilli* are described and illustrated.

KEY WORDS: larvae, embryos, *Heleioporus albopunctatus*, *Neobatrachus centralis*, *Neobatrachus wilsmorei*, *Neobatrachus kunapalari*, *Mixophyes schevilli*, frogs

Introduction

Despite considerable advances over the last twenty years, larval forms of many Australian frogs remain unknown. Tyler (1989) documented those for which descriptions have been published, but the breadth of information available for the listed species varies considerably. For instance, some papers provide a composite description of larvae but lack any early developmental data (e.g. Watson & Martin 1973) or illustrations (e.g. Lee 1967); authors rarely have access to complete life history data.

In addition, larvae attributed to species in the early 1960's may be wrongly identified (e.g. larvae of *Neobatrachus pictus* and *N. centralis*, Martin 1965; Watson & Martin 1973). For this reason additional data are necessary to ensure association of larvae with adults of species as currently recognised.

During studies of the ontogeny of bone of limnodynastine leptodactylid frogs, tadpoles of various species have been reared. Some of these have not been described, or have been unreliably associated with adults. Here I provide information on the early development and larvae of *Heleioporus albopunctatus* and on the larvae of *Neobatrachus centralis*, *N. wilsmorei*, *N. kunapalari* and *Mixophyes schevilli*.

Materials and Methods

Material reported here is housed in the Dept of Zoology, University of Adelaide. Larvae were staged according to Gosner (1960). Measurements were made using dial calipers measuring to 0.05 mm or with the aid of an eyepiece micrometer. Measurements taken (in mm) were: total length (TL), body length (BL).

Line drawings were made with the aid of a camera lucida attached to a Wild M8 stereo dissecting microscope. The format of the larval descriptions follows Anstis (1976).

Results

Heleioporus albopunctatus Gray FIGS 1-5

The earliest stage available was an embryo within the egg membranes at stage 20 (Fig. 1) which is perched on a large yolk sac around which the tail is wrapped laterally. In five of six embryos the tail is wrapped sinistrally and in the sixth, dextrally. The cornea is not yet transparent but the eye is partially pigmented. External gills are not apparent and ventral adhesive organs cannot be located. The stomodaeal pit has differentiated into a mouth consisting of an upper lip overhanging an unperforated mouth cavity. The olfactory pit also is unperforated. A well-developed orifice (anal opening) is located at the junction of the tail with the body (Fig. 1). The embryo is lightly pigmented with a brilliant yellow yolk sac.

By stage 22 the olfactory pit has become perforated to form the nares. Two upper and two lower tooth rows have begun to keratinize. The tail remains wrapped around the yolk and curved up over the face covering one nostril and the corner of the eye (Fig. 2). The yolk sac shows the beginnings of coiling and the anal opening remains prominent. Blood vessels are present on the tail fins. A yellow spot occurs on the top of the head at the level of the anterior extremities of the eyes. The embryo remains in the egg membrane at this stage. External gills are absent but an aperture is detectable on the left hand side in the usual position of external gills. Ventral adhesive organs also are absent. The embryo is covered with a fine dusting of fine brown pigment.

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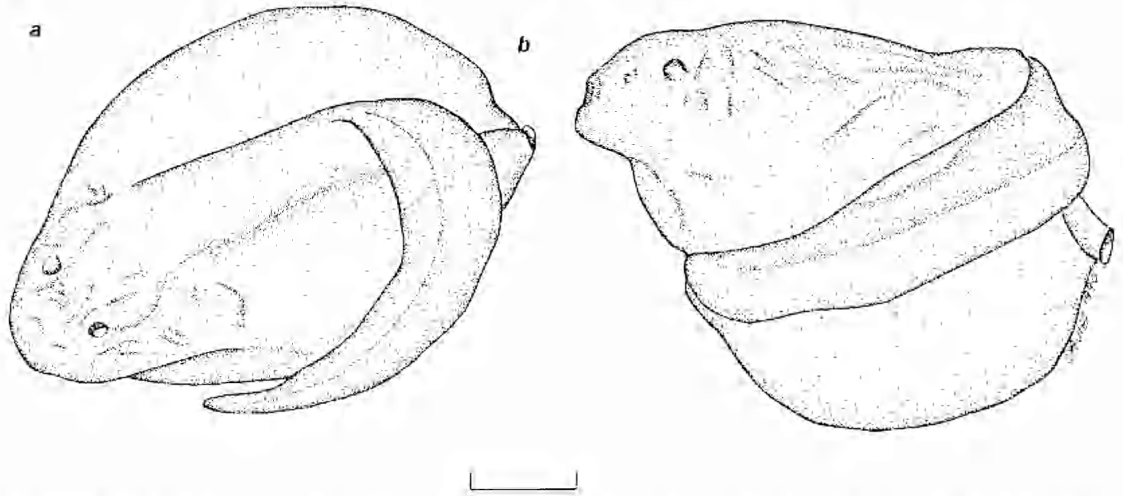


Fig. 1. Embryo of *Heleioporus albopunctatus* at stage 20: a, dorsal and b, lateral views. Scale bar = 1 mm.

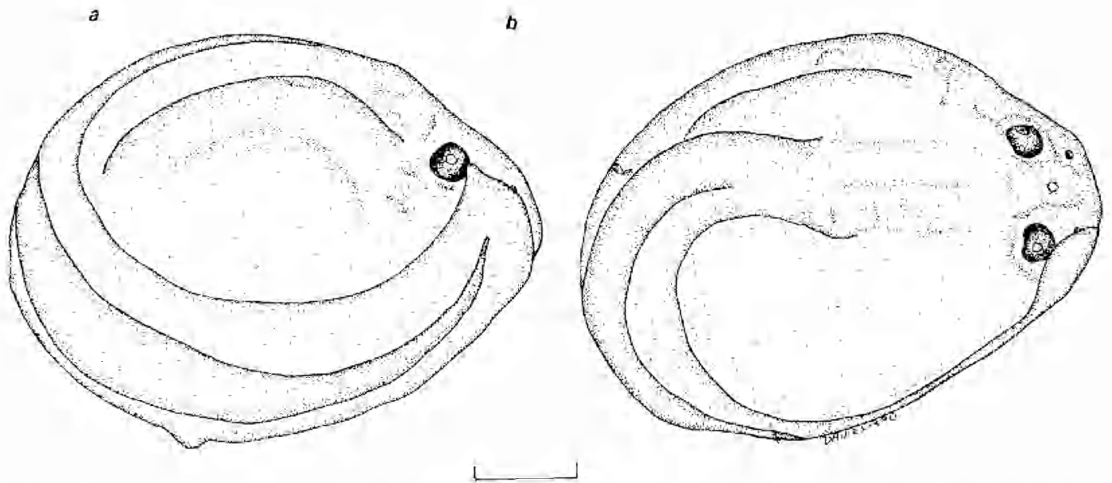


Fig. 2. Embryo of *Heleioporus albopunctatus* at stage 22: a, lateral and b, dorsal views. Scale bar = 1 mm.

By stage 24 the embryos have hatched. The tail is flexed at its tip and the mouth is situated anteroventrally (Fig. 3). Later at this stage the tail loses some of its flexure. The anus is dextral and open. The operculum has closed but the spiracle has not formed.

By stage 25, the mouth is directed anteroventrally. The tail is still very slightly flexed and the spiracle is forming. Coiling of the gut is detectable, but it remains yolk-filled.

At stage 26, the gut appears yolk-filled but is fully coiled. Keratinization is incomplete on the tooth rows but is apparent in some state on all the presumptive mouth structures.

By stage 28 the tadpoles are feeding and the mouth parts are fully formed.

A larva at stage 33 is illustrated in Fig. 4.

The body is elongate and widest at the eyes. The snout is evenly rounded in dorsal view and slopes gently in lateral view. The nares are dorsolateral and sessile. The moderately large eyes are dorsolateral. The spiracle is sinistral, ventrolateral and visible from above. It opens posterodorsally and has a constant diameter along its length. The anal tube is dextral, long and opens about halfway up the ventral fin. The tail fin is not arched and is gently rounded terminally with the dorsal fin extending along the posterior 1/10 of the body and deepest

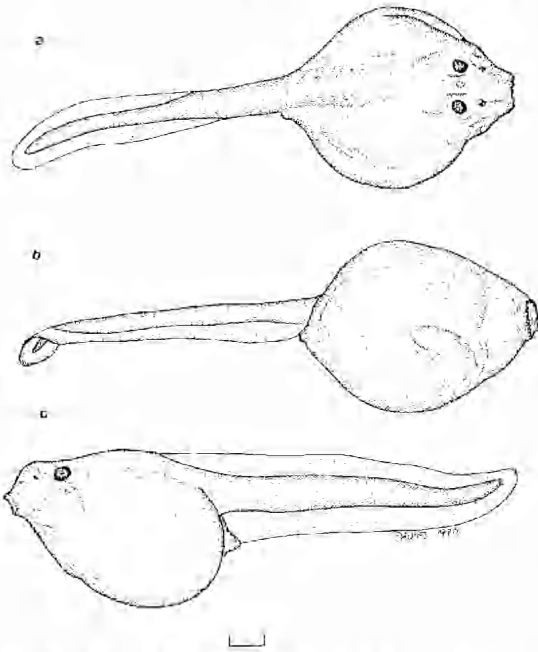


Fig. 3. a, Dorsal, b, ventral and c, lateral views of a larva of *Heleioporus albopunctatus* at stage 24. Scale bar = 1 mm.

approximately halfway along its length. The ventral fin is deepest about 1/3 of the way along its length. Tail musculature is moderately thick and tapers to a fine point posteriorly. The mouth is anteroventral. There are six upper and three lower rows of labial teeth. The second - sixth upper and first lower rows are divided (Fig. 5). The horny beak is of moderate proportions. Tail musculature is pigmented and pigmentation also occurs on the dorsal and ventral fins (Fig. 4).

Meristic data of tadpoles are provided in Table 1.

Comment: Lee (1976 p.388) reported that the tooth row formula as recorded here is the "maximal observed" and that variability occurs: "commonly 1 or 2 complete, up to 5 incomplete upper labial tooth rows; 3 lower labial rows, 2 may be incomplete".

The mouth illustrated in Fig. 5 is essentially the same as that illustrated by Watson & Martin (1973) for *H. australiacus*. However the absence of external gills in developing *H. albopunctatus* is not mirrored in *H. australiacus*. Watson & Martin (1973) reported external gills in this species. No comment was made about absence of adhesive organs. Adhesive organs (oral suckers) rapidly disappear after stage 21

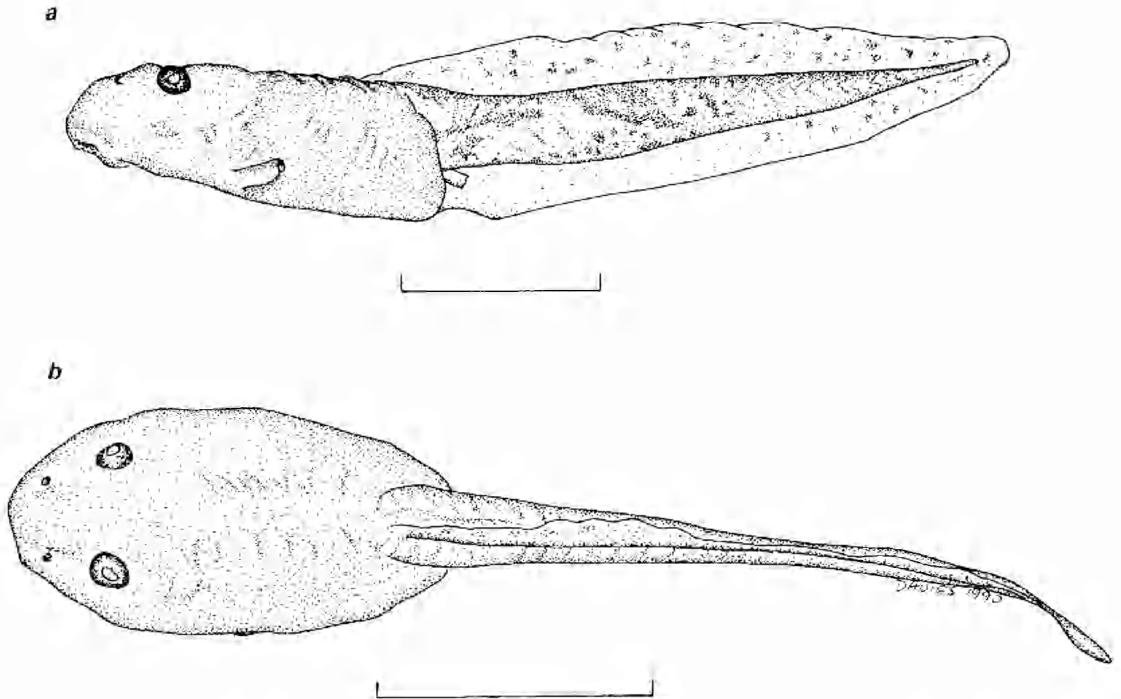


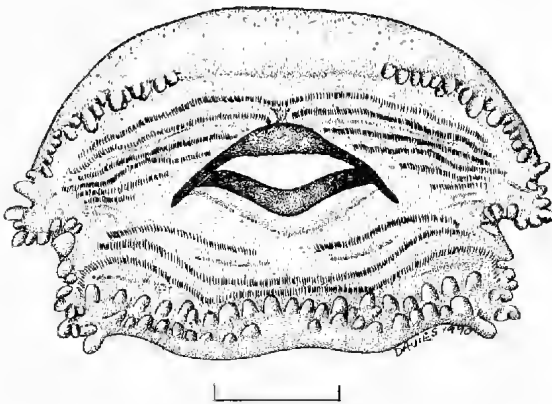
Fig. 4. a, Lateral and b, dorsal views of a larva of *Heleioporus albopunctatus* at stage 33. Scale bar = 10 mm.

TABLE 1. *Measurements (in mm) of tadpoles.*

Species	Stage	Total length \bar{x} (range)	Body length \bar{x} (range)	n
<i>Neobatrachus centralis</i>	27	23.8	9.8	1
	29	36.7	14.9	1
	32	35.5 (35.5)	15.7 (15.6-15.8)	2
	34	37.9 (37.6-38.2)	15.9 (15.3-16.5)	2
	35	37.2	17.4	1
	36	43.31 (33.7-50.7)	18.97 (16.8-23.0)	14
	37	50.0 (48.2-51.8)	22.7 (22.4-23.0)	2
	38	49.99 (46.0-57.1)	21.46 (19.8-25.0)	9
	39	50.93 (49.3-52.3)	23.19 (21.6-23.6)	4
	41	49.77 (45.6-54.5)	19.58 (16.9-21.1)	12
	42	39.47 (35.7-41.7)	17.23 (16.1-18.0)	3
	43	31.38 (22.5-40.7)	17.66 (16.9-19.3)	8
	44	19.43 (15.8-21.6)	16.95 (15.6-20.1)	6
	<i>N. wilsmorei</i>	34	49.6	19.1
40		59.8	26.1	1
41		62.9 (61.4-64.4)	26.1 (25.7-26.5)	2
<i>N. kunapalari</i>	36	40.7	17.1	1
<i>Mixophyes schevilli</i>	24	98.03 (86-116.4)	34.6 (31.1-39.5)	4
	25	87.53 (75.4-107.2)	30.27 (23.3-36.0)	9
	31	58.4	21.5	1
	32	59.2	21.9	1
	33	63.4	22.9	1
	33/34	66.7	23.5	1
	34	64.0	22.9	1
35	68.25 (66.7-70.6)	25.23 (24.6-26.6)	4	

TABLE 1. Measurements (in mm) of tadpoles (continued)

Species	Stage	Total length \bar{x} (range)	Body length \bar{x} (range)	n
<i>Mixophyes</i> (continued) <i>schevilli</i>	37	70.13 (67.2–75.0)	23.63 (23.1–24.2)	3
	38	71.7	23.4	1
	39	74.45 (72.7–76.2)	21.95 (21.2–22.7)	2
<i>Heleioporus</i> <i>albopunctatus</i>	26	15.3	6.0	1
	27	16.4 (16.3–16.5)	6.05 (6.0–6.1)	2
	28	22.6 (20.8–24.4)	8.6 (8.0–9.2)	2
	29	27.0	9.2	1
	33	40.9	14.1	1
	35	45.7 (42.5–47.4)	15.43 (12.5–17.1)	3
	37	47.1	15.1	1
	38	47.25 (46.6–47.9)	17.7 (17.5–17.9)	2
	41	55.9	21.2	1
	42	44.6	18.1	1
	43	28.98 (23.6–34.40)	16.55 (16.0–17.1)	2
44	18.5	18.3	1	

Fig. 5. Oral disc of a larva of *Heleioporus albopunctatus* at stage 33. Scale bar = 1 mm.

(Gosner 1960). The earliest stage examined here is stage 20 and it may be that the structures disappear at an earlier stage in *H. albopunctatus* (the form or oral suckers varies both systematically and ontogenetically (Gosner 1960)).

Mixophyes schevilli Loveridge
FIGS 6–7

A tadpole at stage 36 is illustrated in Fig. 6. The body is ovoid and widest behind the eyes. The snout is evenly rounded in dorsal and lateral views. The nares are dorsal and sessile, opening laterally. The relatively-large eyes are dorsolateral. The spiracle is sinistral, short and ventrolateral with a large orifice directed posterodorsally, and is not visible from above. The diameter of the spiracular tube is

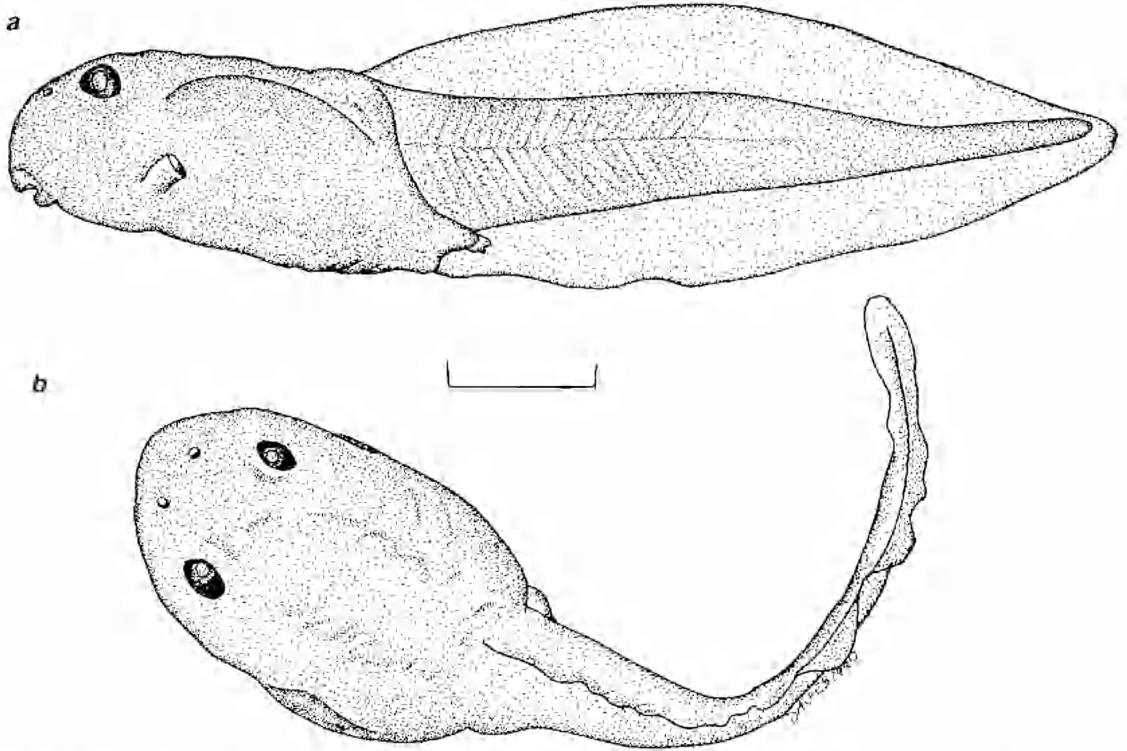


Fig. 6. a, Lateral and b, dorsal views of a larva of *Mixophyes schevilli* at stage 36. Scale bar = 10 mm.

relatively constant along its length. The anal tube is dextral and hidden in a membranous sac which also surrounds the developing hind limbs. At this stage, the feet protrude from the sac. The anus opens about halfway up the ventral fin. The tail fins are arched, the dorsal fin commencing in the posterior 1/10 of the body, being deepest approximately half way along its length. The tail fin is slightly rounded at its terminus. Tail musculature is thick, tapering to a point posteriorly. Tadpoles are heavily pigmented, pigmentation extending over the tail musculature and fins. The mouth is ventral with the oral disc surrounded by a papillary border of moderately fine papillae (Fig. 7). There are six upper and three lower rows of labial teeth and five or six rows occur laterally on each side near the angle of the jaw. All the upper rows except the most anterior are divided. The second and third lower rows are undivided. The horny beak is of relatively fine proportions.

Meristic data on tadpoles of *M. schevilli* are provided in Table 1.

Comment: *M. schevilli* can overwinter as very large tadpoles at stage 25 (Trenerry 1988¹). This phenomenon is reflected in the mensuration data.

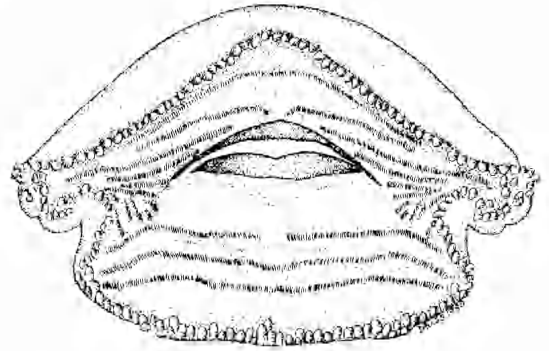


Fig. 7. Oral disc of a larva of *Mixophyes schevilli* at stage 36. Scale bar = 1 mm.

¹Trenerry, M. P. (1988) The ecology of tadpoles in a tropical rainforest stream. B.Sc. (Hons) Thesis, Dept of Zoology, James Cook University of North Queensland. Unpubl.

Some of the material measured was reared to metamorphosis in the laboratory whilst the remainder was collected and preserved in the overwintering condition at stage 25.

Tyler (1965) described the oral disc of *M. schevilli* as *Litoria nannotis* (Liem 1974). He recorded six upper and three lower tooth rows, but only three lateral rows of teeth.

Martin (1967) reported six upper, three lower lateral and three lower labial tooth rows with a complete papillary border in *M. fasciolatus* whilst Watson & Martin (1973) recorded six upper, five to six lower lateral and three lower labial tooth rows with a complete papillary border in *M. halbus*. The mouth of this species, illustrated by Watson & Martin (1973, Fig. 4B), is very similar to that of *M. schevilli* reported here. These authors also reported development of the hind limbs in a membranous sac in the early stages. This latter phenomenon presumably is a lotic adaptation shared with other sympatric stream-dwelling species such as *Nyctimystes dayi* and *Litoria nannotis* (Davies &

Richards 1990). However, lotic adaptations in *M. schevilli* are not as prominent as those of *M. fasciolatus* (Martin pers. comm.).

Neobatrachus wilsmorei (Parker)
FIGS 8-9

A tadpole at stage 34 is illustrated in Fig. 8. The body is elongately ovoid and widest posterior to the eyes. The snout is slightly truncated in dorsal view and gently sloping in lateral view. The nares are dorsal, sessile and poorly-separated. The relatively-large eyes are dorsolateral. The spiracle, with an attached inner edge, is sinistral, ventrolateral and not visible from above. The spiracular opening is wide; the diameter of the spiracular tube decreases slightly from its origin to its opening. The anal tube is dextral, relatively long and opens about $\frac{2}{3}$ of the way down the ventral fin. The tail fins are arched and rounded terminally, the dorsal fin commencing in the posterior $\frac{1}{3}$ of the body, being deepest

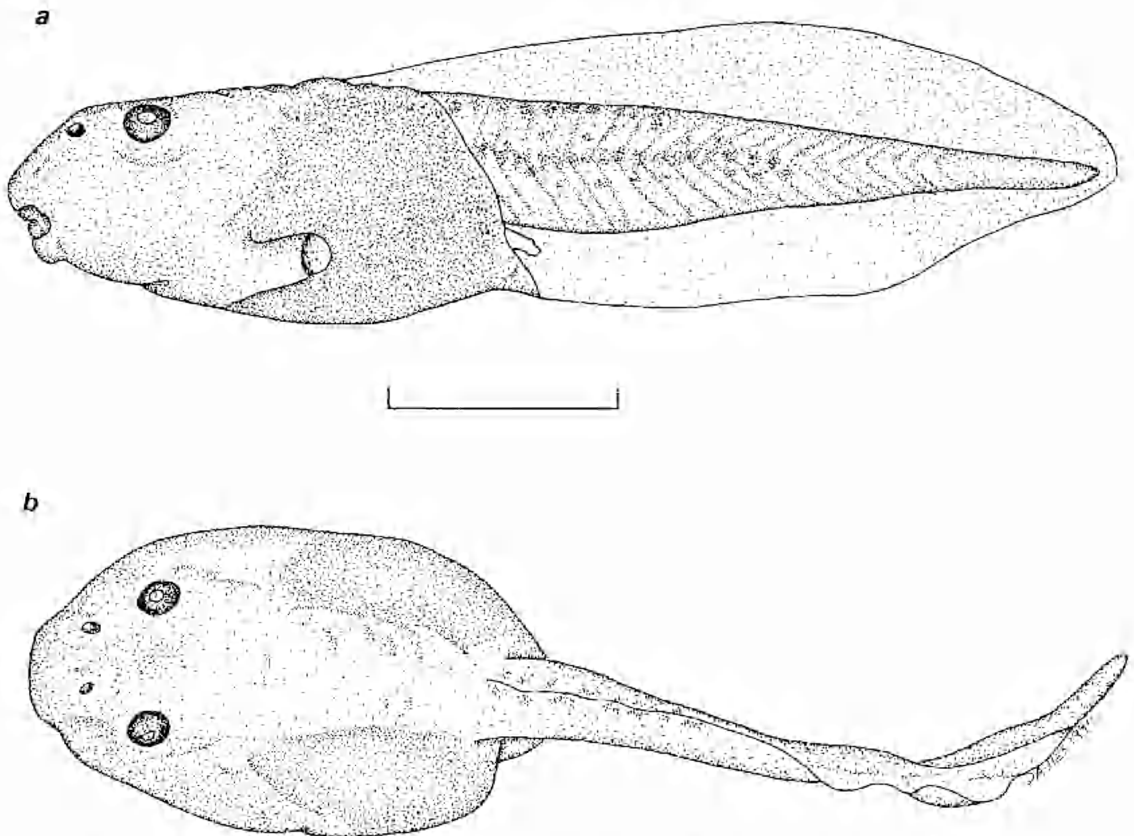


Fig. 8. a, Lateral and b, dorsal views of a larva of *Neobatrachus wilsmorei* at stage 34. Scale bar = 10 mm.

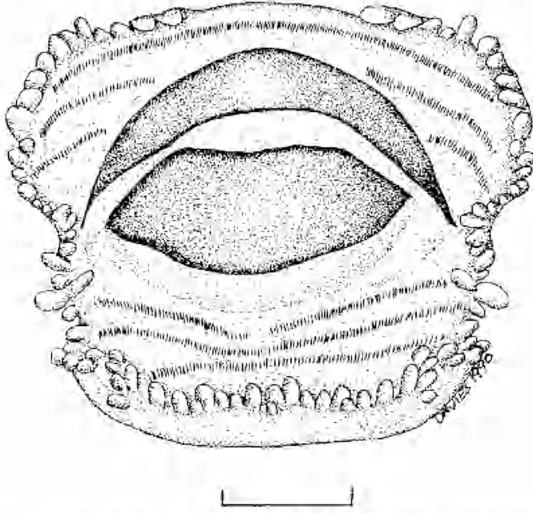


Fig. 9. Oral disc of a larva of *Neobatrachus wilsmurei* at stage 34. Scale bar = 1 mm.

approximately $\frac{2}{3}$ along its length. The ventral fin is deepest about halfway along its length. Tail musculature is thick, narrowing to a fine point posteriorly.

The mouth is anteroventral. Labial papillae extend anterolaterally, laterally and posteriorly

around the mouth disc with an anterior median gap (Fig. 9). There are three upper and three lower labial tooth rows. The first upper and the second and third lower rows remain undivided. The horny beak is robust.

Tail musculature is finely pigmented as is the dorsal fin. The ventral fin is pigmented only in its posterior third. The head and body are dusted with fine pigment.

Keratin appears on the distal edge of the inner metatarsal tubercle at stage 41.

Measurements of this tadpole are shown in Table 1. A metamorphosing tadpole at stage 45 had a snout-vent length of 20.6 mm.

Neobatrachus centralis (Parker)
FIGS 10-11

A tadpole at stage 36 is illustrated in Fig. 10. The body is ovoid and widest across its mid region. The snout is evenly rounded in dorsal view and lateral view. The nares are dorsal, sessile and poorly-separated, opening anterolaterally. The relatively large eyes are dorsolateral. The spiracle is sinistral, ventrolateral, not visible from above and with an attached inner edge. The wide orifice opens dorsally and the spiracular tube increases in diameter very slightly from its origin to its opening. The anal tube

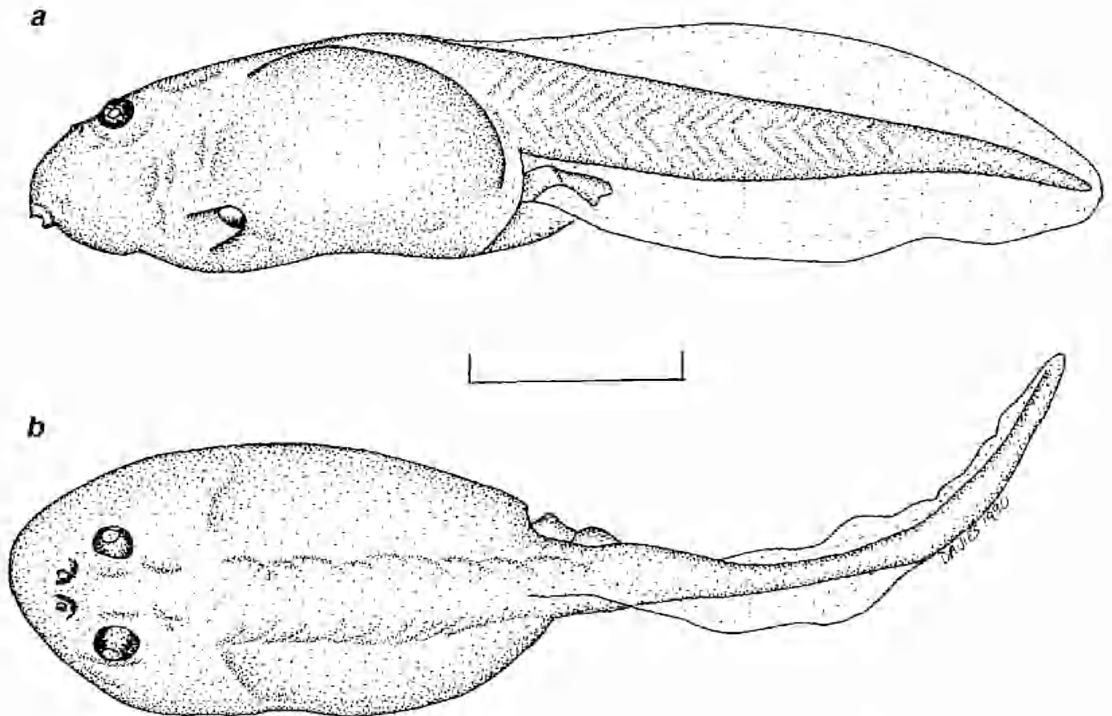


Fig. 10. a, Lateral and b, dorsal views of a larva of *Neobatrachus centralis* at stage 36. Scale bar = 10 mm.

is median and relatively long. The tail fins are arched and rounded terminally, the dorsal fin not extending over the body and deepest approximately halfway along its length. The ventral fin is deepest approximately halfway along its length. Tail musculature is moderately thick narrowing to a point posteriorly. The mouth is anteroventral.

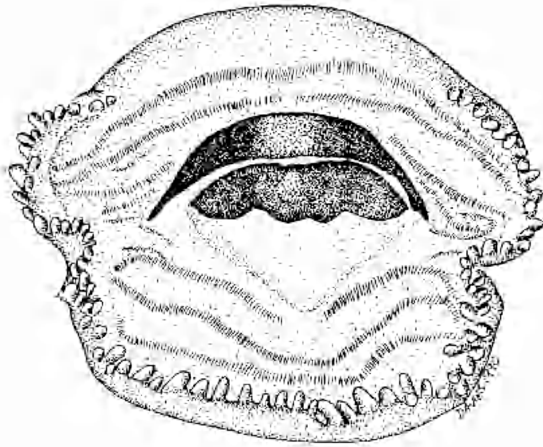


Fig. 11. Oral disc of a larva of *Neobatrachus centralis* at stage 36. Scale bar = 1 mm.

Labial papillae extend anterolaterally, laterally and posteriorly around the mouth disc, being interrupted anteriorly. There are four upper and three lower rows of labial teeth (Fig. 11). The first upper and second and third lower rows are undivided.

A dark pigment crescent is located around the nares. The remainder of the body is dusted with pigment granules. A very faint dusting of pigment granules covers the tail musculature and the dorsal fin but is absent from the ventral fin.

Earlier stages of *N. centralis* have little or no pigment. Keratin is formed on the distal edge of the inner metatarsal tubercle at stage 41. A metamorphosing individual at stage 45 had a snout-length of 14.5 mm. Measurements of *N. centralis* tadpoles are shown in Table 1.

Neobatrachus kunapalari Mahony & Roberts
FIGS 12-13

A tadpole at stage 36 is illustrated in Fig. 12. The body is ovoid and widest posterior to the eyes. The snout is evenly rounded in dorsal view and gently sloping in lateral view. The nares are dorsal, sedentary and opening anterolaterally. The relatively-large eyes are dorsolateral. The spiracle is sinistral, ventrolateral, not visible from above and with an attached inner edge. It opens dorsally and the tube diameter decreases very slightly along its

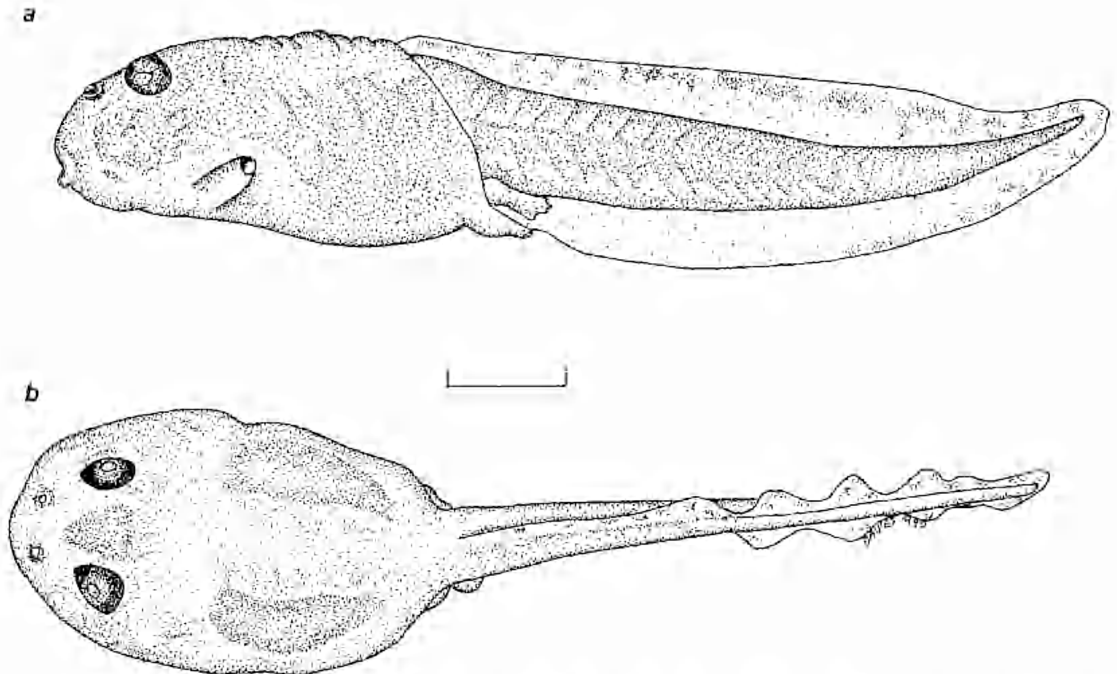


Fig. 12 a, Lateral and b, dorsal views of a larva of *Neobatrachus kunapalari* at stage 36. Scale bar = 10 mm.

length from the origin to the orifice. The anal tube is long, dextral and opens about $\frac{2}{3}$ of the way up the ventral fin. The tail fins are poorly-arched and rounded terminally. The dorsal fin does not extend along the body and is deepest about halfway along its length. The ventral fin is deepest about halfway along its length. Tail musculature is moderately thick, narrowing terminally.

The mouth is anteroventral. Labial papillae extend anterolaterally, laterally and posteriorly being interrupted anteromedially (Fig. 13). There are three upper and three lower rows of labial teeth. The third upper and first lower rows are divided. The horny beak is of moderate proportion.

The head and body are heavily dusted with pigment, as are tail fins and tail musculature. A

circle of very dark pigment surrounds the nares. The ventral surface is unpigmented.

Comment: More species of *Neobatrachus* have been described or redefined in recent times than of any other limnodynastine genus (Tyler & Ledo 1973; Roberts 1978; Tyler *et al.*, 1981; Mahony & Roberts 1986). For this reason, the data supplied by Martin (1965) for *N. pictus* and by Watson & Martin (1973) for *N. centralis* may have been based on misidentified material. Tyler (1989) reidentified the *N. pictus* of Martin (1965) as *N. sudelli* and a redescription of *N. centralis* is provided here.

Neobatrachus tadpoles are known to grow to a very large size in their natural state: Martin (1967) reported tadpoles of 73 mm total length.

N. centralis and *N. wilsmorei* are closer to the short body with a strongly arched tail recorded for *N. sudelli* and *N. pictus* by Martin (1965) and Watson & Martin (1973) than is *N. kunapalari* which has a more streamlined body. None of the species examined here has the spiracle free along its inner edge as reported in *N. sudelli* by Martin (1965).

Acknowledgments

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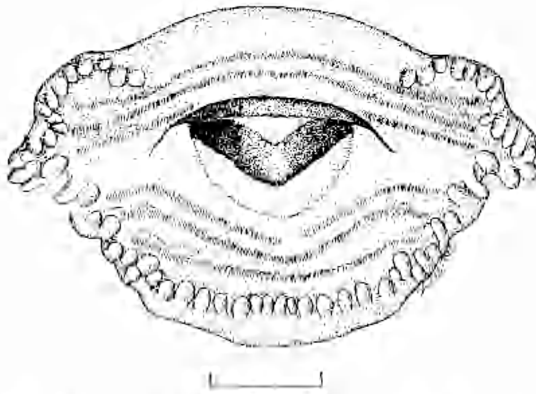


Fig. 13. Oral disc of a larva of *Neobatrachus kunapalari* at stage 36. Scale bar = 1 mm.

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